REVIEWS

MEASURING THE PRODUCTION OF MARINE PHYTOPLANKTON. *By J. D. H. Strickland. (Fisheries Research Board of Canada, Bulletin No. 122). The Queen's Printer, Ottawa. 1960. 172 pp., 9 tables. $2.00.*

The author states that there is "no comprehensive and critical review of marine primary productivity that serves as an adequate introduction to the subject in all its aspects for workers about to commence active research in this field." In this publication the author attempts to satisfy this need by presenting in clear, concise language an excellent introduction to the measurement of primary productivity of marine phtyoplankton. Not only is he successful in providing a valuable text for new workers, but also he raises questions which might profitably be further examined by researchers already in the field.

The publication is divided into five sections. A table of contents, a glossary of symbols and abbreviations, introductory remarks, and an extensive bibliography are also included.

In any introductory text an author is confronted with the problem of using terms, which although familiar to the experienced worker, are unknown to the neophyte. The author, realizing this, has devoted an entire section to a compact, yet thorough, discussion of definitions and conversion factors.

In a discussion of the chemical composition of phytoplankton in Section II the author adequately covers the elementary composition, the major molecular constituents, and the pigments used in measuring primary productivity. Briefly covered in each instance is a review of the literature, the relationship between constituents, the degree of variations in measurements and their causes, and the limitations of values determined for each constituent as used in reporting the findings. Possible solutions for some of the problems which arise when measuring chemical composition of phytoplankton are given, and several techniques with their limitations used for obtaining these measurements are introduced.

The primary problem of measuring a standing crop of organisms is to obtain a representative sample of a population which is distributed unevenly over an extensive area. In Section III the author covers the problem of gear selection, of processing the sample, and of separating phytoplankton from all organic matter of animal origin and detritus. This is followed by a discussion of the techniques employed in estimating primary productivity from carbon content, nitrogen, phosphorus, and specific organic constituents, and by pigment analysis. Discussing each phase separately, the author provides a brief review of the literature succeeded by a discussion of the limitations. This section is terminated with a discussion of some results of standing crop determination obtained by various workers.

Section IV, a discussion of the measurement of the rate of photosynthesis, is by far the best portion of the text. Introducing this topic, the author provides an informative discussion of oxygen and carbon dioxide requirements and relationships, photosynthetic and respiratory quotients, effects of illumination on respiratory algae, and participation of intracellular material and the interpretation of radiocarbon productivity measurements. The problem of sampling and direct measurements is discussed again, and although slightly repetitious of Section III, this additional coverage is beneficial to the neophyte in that it provides further insight into the problems encountered in the field and laboratory. Having presented this background information, the author then covers the measurement of the rate of photosynthesis by carbon dioxide consumption, the oxygen evaluation (dark and light bottle), the rate of carbon-14 uptake, methods based on pigment content, and finally by other methods which involve depth profiles of oxygen or phosphorus concentrations and the uptake of phosphorus. In each instance he provides a brief review of the literature, general techniques, limitations, and special considerations to be taken into account. Terminating the discussion of measuring the rate of photosynthesis, the author provides a table and brief discussion of selected examples of productivity measurements.

Section V is "a detailed discussion of the measurement of primary productivity in nature and of methods designed to predict *in situ* productivity with the minimum amount of experimentation." Before delving into this subject, the author provides a brief discussion of the concept of the productivity index of a water mass. Then, in a discussion of general kinetics, the author covers the kinetics of unicellular growth and decay, the influence of light, and the diurnal fluctuation of organisms as related to timing of experiment. Concluding the text, productivity measurement in nature is presented with the author providing additional observations on population changes in nature and the *in situ* production and its prediction from experimental work using light incubators.

Mr. Strickland has shown that he is well acquainted with his field, and the direct, clear manner in which the material is presented is to be commended. The reference section, although not covering the entire field, is an adequate introduction to the beginner as well as a usful tool to the experienced worker.

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RATE OF METABOLISM AND FOOD REQUIREMENTS OF FISHES. *By G. G. Winberg. (Fisheries Research Board of Canada, Translation Series No. 194). (Published in Nauchnye Trudy Belorusskovo Gosudarstvennovo Universiteta imeni V. I. Lenina, Minsk, 253 pp., 1956). Fisheries Research Board of Canada, Biological Station, Nanaimo, B. C. 1960. 202 pp., 54 figs., 32 tables.*

This translation of G. G. Winberg's monograph represents a cooperative enterprise of the Fisheries Research Board of Canada, the Department of Zoology of the University of Toronto, and the Research Division of the Ontario Department of Lands and Forests.

Much of the monograph is devoted to reviewing the various relationships of the metabolic rate of fish to factors such as temperature, the oxygen content of water, total body size and weight, salinity, diurnal fluctuations in metabolism, and differences between species. In this discussion he is concerned

only with measurements of the *rate* of metabolism. Physiological and biochemical mechanisms of fish metabolism, although acknowledged to be important, are not considered.

During the discussion of metabolic rate and total body size, considerable effort is expended in showing that the relation of metabolism to size can be expressed by a parabolic equation, *i.e.*, $Q = Aw^k$, where Q is the rate of oxygen consumption, A is a coefficient equal to the total metabolism of an amount of unit weight, w is the weight of the animal, and k is a constant indicating at what speed and in which direction the metabolic rate changes when weight increases. In explaining this relationship he has attempted to use all of the published results of measurements of fish metabolic notes. Not every measurement examined was included in the analysis, however, as only those data accompanied by weight and in a form that could be adjusted to milliliters of oxygen consumed per gram of weight per hour at 20 degrees Centigrade could be used.

These data are grouped according to related species in 13 tables, including for each observation the name of the fish, the author and year of publication of the source paper, the method of determination used by the author, the number of determinations, the average temperatures at which measurements were obtained, and the average value of the rate of metabolism expressed in the units used in the original paper. The result is 369 pairs of weight and metabolic rate data. However, for various reasons certain data on single measurements of very tiny fish were excluded. For the remaining 364 pairs of values Winberg obtains: $k = 0.815 \pm 0.0105$. He expresses as a first approximation, the general relationship between the mean value of total metabolism and weight by the equation, $Q = 0.3\, w^{0.8}$. This equation is basic to the understanding of much of the remainder of the monograph.

Brief comparisons of metabolic rates of crustaceans and warm-blooded vertebrates with fishes are also made.

A discussion of differences in the metabolic rates of ecological groups is included. In a portion of this commentary Winberg states, as a hard, incontrovertable fact, that the question of differences in the relative metabolic rate of marine and fresh-water fishes can be regarded as solved since he shows the average metabolism is the same for the two groups. This may well be so, but the evidence is certainly empirical and does not warrant such dogmatism. For instance, he shows that k for marine fish is equal to 0.79 ± 0.014, while for fresh-water fish it is 0.81 ± 0.014. The differences, though small, are nonetheless differences, and their very existence does not support his attitude of finality. This criticism by the reviewer must appear to the reader as an instance of making a "mountain of a mole hill," but at this point in the monograph the uncompromising and dogmatic style of the author begins to obtrude on the sensibilities.

A discussion of active metabolism and energy expenditures of fish in motion is included and points up the present lack of knowledge and the necessity for more and careful work on this aspect of fish metabolism.

The balance of the monograph is concerned with the food requirements portion of the title and the dynamics of the growth and metabolism of fish. The interrelationship of growth, food, and metabolic rate are considered, and computation methods for determining such things as the rate of increase in weight and the food intake of fish are developed.

In these areas the author apparently feels more confident, and even when he disagrees with a source his criticism is less acrid.

The review of literature alone is valuable because of its highly critical but often polemic discussion of Russian work in the field of fish metabolism through 1954. Approximately 90 Russian papers are cited, of which not more than 10 have been used in English reviews available to me. I use the term "approximate" because text citations do not always appear in the list of references. He has not limited himself to Russian workers alone but also includes 136 non-Russian papers.

The compilation of data in the numerous tables of the monograph will prove to be the most useful compendium of information on the metabolic rate and food requirements of fish now available. In addition to the 13 composite tables of measurements of rate of oxygen consumption for such diverse species groups as minnows, sturgeons, and lampreys, there is a series of 7 tables of growth rate, food consumption, and metabolic rate for various species.

The air of personal infallibility displayed by Professor Winberg in dealing with data and authors who do not agree with him, adds neither dignity nor stature to his position as a scientist.

Despite his dialectic shortcomings, Professor Winberg has contributed a useful and important monograph on the subject and implications of the metabolic rate of fishes.

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Recent Publications

Alexander, Elizabeth C.
A Contribution to the Life History, Biology and Geographical Distribution of the Bonefish, *Albula vulpes* (Linnaeus). *(Dana Report No. 53). Carlsberg Foundation, Copenhagen. 1961. 51 pp. 15. Danish Kr.*

American Association of Petroleum Geologists
Recent Sediments, Northwest Gulf of Mexico. *A symposium summarizing the results of work carried on in Project 51 of the American Petroleum Institute, 1951–1958. Edited by Francis P. Shepard, and others. Tulsa, Oklahoma. 1960. 394 pp. $7.00.*

Bearden, Charles M.
Common Marine Fishes of South Carolina. *(Contributions No. 34). Bears Bluff Laboratories, Wadmalaw Island, South Carolina. 1961. 47 pp.*

Borgstrom, Georg, ed.
Fish as Food. Volume 1: Production, Biochemistry, Microbiology. *Academic Press, New York. 1961. 725 pp. $24.00.*

Dogiel, V. A., and others, eds.
Parasitology of Fishes. *Translated by Z. Kabata. (Published by Leningrad University Press, 1958). Oliver and Boyd, Edinburgh. 1961. 384 pp. 84 s.*

Fisheries Year-Book and Directory, 1961. *British-Continental Trade Press, Ltd., London. 1961. 20 s.*